



FAA-E-2384
January 22, 1969

DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION SPECIFICATION

AZIMUTH PULSE GENERATORS, ARSR ANTENNA

1. SCOPE AND CLASSIFICATION

1.1 Scope. - This specification sets forth the requirements for an Azimuth Pulse Generator (APG) to be mounted on Air Route Surveillance Radar (ARSR) antenna pedestals. When mounted on the radar antenna pedestal and coupled to the ARSR antenna drive system, the APG is to generate 4096 incremental pulsed outputs and one reference pulse for each 360 degree rotation of the radar antenna.

1.2 Classification. - Two types of APG assemblies are specified herein, differing in the type of ARSR antenna pedestal to which they are designed for mounting:

Type I	ARSR-1 Antenna Pedestal, CA-4003
Type II	ARSR-2 Antenna Pedestal, FA-7002

2. APPLICABLE DOCUMENTS

2.1 FAA documents. - The following FAA specifications and standard of the issues specified in the invitation for bids or request for proposals, form a part of this specification.

2.1.1 FAA specifications

FAA-G-2100/1	Electronic Equipment, General Requirements; Part I, Basic Requirements for all Equipments
FAA-G-2100/3	Part 3, Requirements for Equipments Employing Semiconductor Devices
FAA-G-2100/4	Part 4, Requirements for Equipments Employing Printed Wiring Techniques
FAA-D-1272	Instruction Booklets, Electronic Equipment

2.1.2 FAA standard

FAA-STD-013	Quality Control Program Requirements
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2.2 Military and Federal Publications. - The following Military publications, of the issues in effect on the date of the invitation for bids or request for proposals, form a part of this specification.

2.2.1 Military specifications

MIL-E-17555	Electronic and Electrical Equipment and Associated Repair Parts, Preparations for Delivery of
MIL-HDBK-217	Reliability Stress and Failure Rate Data for Electronic Equipment

(Copies of this specification and other applicable FAA specifications, standards and drawings may be obtained from the Contracting Officer in the Federal Aviation Administration Office issuing the invitation for bids or request for proposals. Requests should fully identify

material desired, i.e., specification, standard, amendment, and drawing numbers and dates. Requests should cite the invitation for bids, request for proposals, or the contract involved or other use to be made of the requested material.)

(Information on obtaining copies of Federal specifications and standards may be obtained from General Services Administration Offices in Atlanta; Auburn, Wash.; Boston; Chicago; Denver; Fort Worth; Kansas City, Mo.; Los Angeles; New Orleans; New York; San Francisco; and Washington, D. C.)

(Single copies of Military specifications and standards may be obtained from Federal Aviation Administration, Washington, D. C., 20590, ATTN: Contracting Officer. Requests should cite the invitation for bids, request for proposals, or contract for which the material is needed. Mail requests, if found acceptable, will be forwarded to a Military supply depot for filling; hence, ample time should be allowed.)

3. REQUIREMENTS

3.1 Equipment to be furnished by the contractor. - Each Type I and Type II Azimuth Pulse Generator furnished by the contractor shall be complete in accordance with all specification requirements and shall include the items tabulated below. Instruction booklets shall be furnished in accordance with FAA-D-1272 in quantities specified in the contract schedule.

- (a) Azimuth Pulse Generator complete with electronic circuitry (as required) and coupling to the antenna drive system (3.4.1; 3.4.2; 3.4.3)
- (b) Special tools (3.7)
- (c) Installation and modification hardware (3.8)
- (d) Cabling (3.9)

3.2 Prototype equipment. - Insofar as the contract schedule may require one or more prototype equipments, these shall meet all requirements of paragraph 3.12 and subparagraphs thereunder.

3.3 Service conditions. - The equipment shall be designed to operate over the range of service conditions specified for Environment III (FAA-G-2100/1, paragraph 1-3.2.23) except that wind conditions and ice loading shall not be applicable.

3.4 Equipment design. - The equipment specified herein shall provide for conversion of angular rotation of the radar antenna to output signals representing incremental changes in azimuth of the antenna. The antenna rotation rate is 6 RPM \pm 10%. Viewed from the top, the antenna rotates clockwise. When mounted on the ARSR antenna pedestal and coupled to the rotating mechanism of the antenna drive system, the APG shall generate 4096 equally-spaced Azimuth Change Pulse (ACPs) and one north mark Azimuth Reference Pulse (ARP) for each 360 degree rotation of the antenna. These output pulses will provide the azimuth synchronization input to external digital equipment used for processing of radar data. The overall accuracy of the radar data processing subsystem is dependent on the capability of the APG to generate electrical pulses which define the azimuthal position of the antenna with minimum error. The design shall be such that the required modification to the antenna pedestal can be accomplished with on-site hand tools.

3.4.1 Pulse generator. - The equipment shall use either an electro-magnetic encoder or optical disc encoder to generate azimuth change and reference pulses. Incandescent lamp light sources or brush-type encoders shall not be used.

3.4.2 Construction. - The equipment shall be constructed to withstand the operational environment of shock and vibration that is encountered when mounted on the radar antenna pedestal and meet performance requirements over the range of service conditions (3.3). Sealed contact, reed-type relays shall be used in any equipment design which requires sensing the make or break of mechanical contacts. Such relays shall require specific written approval of the Government. Where equipment design necessitates the use of active or passive circuitry to meet specification requirements, the equipment shall be constructed using solid-state components.

3.4.3 Mounting. - Installation or modification equipment provided by this specification shall be designed to mount the APG assembly on two types of ARSR antenna pedestals. The Type I equipment shall be designed for mounting within the enclosure for the CA-4003 Antenna Pedestal; the Type II equipment shall be designed for mounting within the enclosure for the FA-7002 Antenna Pedestal. Presently housed within the weather-tight enclosures for both type pedestals are the antenna rotary joint, two-speed synchro system, and associated gear-train drive mechanism. When the equipment is mounted on the pedestal, angular rotation of the antenna shall be coupled to the input of the APG using one of the following methods:

- (a) Mechanical coupling to the antenna drive mechanism at the most feasible point in the gear-train where the angular velocity is nearest that of the antenna. This method shall minimize the total coupling backlash between the antenna pedestal bearing gear and the input

shaft to the APG. During the starting cycle of the radar antenna, the APG gear-train mechanism shall be designed to accept the additional torsional load that occurs when the APG input shaft is accelerated from a stop condition to rates up to 30 degrees per second per second, referenced to the angular rotational rate of the antenna, for a period of 5 seconds.

- (b) Direct drive coupling using an optical disc encoder (3.4.1) which is attached to the antenna rotary joint. The disc pattern shall generate 4096 ACPs and one ARP for each 360 degree rotation of the rotary joint.

3.4.3.1 ARP adjustment. - The equipment shall include the provision for azimuthal adjustment of the Azimuth Reference Pulse. When the equipment is installed on the antenna pedestal, the ARP shall be adjustable so that it is generated within a range of values ± 180 degrees of the position of the rotating radar antenna when it passes through north azimuth. Provisions in external digital equipment will permit precise synchronization of the ARP and the north position of antenna.

3.4.3.2 Mechanical isolation. - The equipment and the two-speed synchro system shall not use a common point in coupling to the antenna drive system (3.4.3a). The APG and synchros shall operate independently such that failure or removal of either shall not interfere with proper operation of the other. A frangible-type coupler, or equal shall be used for coupling the APG input shaft to the antenna drive gear-train. Steel pins or set-screws shall not be used to secure the input shaft to the antenna drive system.

3.4.4 Power source. - Equipment shall operate from a single-phase two-wire AC line if external power is necessary because of equipment design. The design-center voltage (1-3.2.21, FAA-G-2100/1) shall be 120 V.

3.4.5 RF environment. - The equipment shall be designed to meet performance requirements of this specification over the range of service conditions (3.3) during operation in the RF environment encountered on the antenna pedestal of ARSR's operating in the 1280 to 1350 MHz frequency range and with the secondary radar operating at 1030 MHz frequency.

3.4.6 Output characteristics. - The output characteristics of Azimuth Change Pulses and the Azimuth Reference Pulse derived from the antenna pedestal mounted APG shall be as follows:

- (a) Azimuth Change Pulses (ACPs): A series of 4096 pulses generated for each 360 degree rotation of the antenna. An output waveform approximating a sine wave is acceptable. At an antenna rotational rate of 6 RPM, the incremental ACP output will occur at an approximate frequency of 410 Hz.

- (b) Azimuth Reference Pulse (ARP): A single pulse, as one ARP, for each 360 degree rotation of the antenna. An output waveform approximating a sine wave is acceptable. The ARP shall be generated midway between two ACPs.
- (c) Pulse Amplitude (ACPs and ARP): At least 3 volts peak on positive-going excursions.
- (d) Output isolation: Separate output connectors shall be provided for the ACP and ARP signals. Isolation between outputs, including hum and noise, shall be 40 dB or more.

The above characteristics shall be met when measured at the ends of RG-59/U coaxial for any cable length up to 300 feet when terminated in the characteristic impedance of the generator output.

3.5 Performance. - The equipment shall meet the following performance requirements over the range of service conditions:

- (a) ACP: 4096 per 360° of antenna rotation
- (b) ARP: One every 360° of antenna rotation
- (c) ACP jitter pulse-to-pulse: Within ± 10% of the nominal ACP interval.
- (d) ARP jitter: Within ± 20% of the nominal ACP interval from the mid-point between two ACPs.
- (e) Azimuth accuracy: Referenced to the first ACP generated after the ARP, the azimuth pulse count output from the APG shall indicate the angular position (θ) of the antenna, as determined by the position of the antenna pedestal bearing gear, with an angular error not to exceed ± 0.045 degrees. With the antenna rotating at 6 RPM ± 10%, the equivalent angular position generated by the APG shall be as follows:

$$\theta = \left(\frac{360^\circ \times \text{ACP number}}{4096} - 0.044^\circ \right) \pm 0.045^\circ$$

Azimuth change and reference pulse spacing shall be measured from leading edge-to-leading edge at the 50% amplitude points.

3.6 Reliability and maintainability. - The equipment shall be designed for continuous and reliable operation. Reliability and maintainability requirements shall be as follows:

- (a) Mean-time-between-failure (MTBF): 15,000 hours minimum

- (b) Mean-time-to-repair (MTTR): one hour maximum
- (c) Preventive maintenance downtime,
including lubrication and adjustment: one hour maximum,
after at least one year
of continuous
operation

Equipment MTBF predictions shall be based on reliability stress and failure rates contained in MIL-HDBK-217. When parts are not included in the coverage of MIL-HDBK-217, existing available failure rate data or valid predictions shall be used to calculate reliability.

3.7 Special tools. - All special tools required for installation, test, or maintenance of the equipment shall be furnished.

3.8 Installation and modification hardware. - All installation or modification hardware that is necessary to mount the APG assembly on either ARSR pedestal (3.4.3) shall be furnished.

3.9 Cabling. - Each equipment shall be furnished with a 200-foot cable harness for interconnecting the APG to external equipment in the radar building. Mating connectors shall be provided for both ends of the harness and installed only on cable ends which connect to the APG.

3.10 Nameplate. - A nameplate shall be provided with each equipment. The title for Type I and Type II equipments shall be AZIMUTH PULSE GENERATOR (1-3.13, FAA-G-2100/1). Note that type designations for nameplates will be assigned; the specification types I and II shall not appear on the nameplates.

3.11 Standard antenna pedestal samples. - Standard samples of the CA-4003 and FA-7002 Antenna Pedestals are located at the Federal Aviation Administration Depot, Engineering and Production Branch, AC-440, Oklahoma City, Oklahoma. One of each type antenna pedestal will be available for inspection by prospective bidders. These samples will remain at the Depot and shall be used by the contractor as standards for designing the equipment specified herein. Due to the limited supply of pedestals, standard samples will not be available for shipment to the contractor's plant. Manufacturing drawings of the pedestals are not available from the Government.

3.12 Optional prototype equipment. - Prototype equipment shall meet all requirements of this specification except as modified by the following subparagraphs. The prototype equipment shall be a model suitable for complete evaluation of mechanical and electrical configuration, design and performance. It shall be of final configuration, employ components of the types to be used in production, and be completely representative of final equipment.

3.12.1 Equipment design. - Where it appears that a substantial cost benefit or improved performance may result from the use of circuits, materials, parts, processes, and construction other than those specified herein, the contractor shall request approval for their use from the Contracting Officer.

3.12.2 Design data. - As may be provided in request for proposals, each bidder shall define his preliminary design approach. The design data (see paragraph 6.4.2) shall include all elements of the equipment to be produced and all modifications that will be required to the CA-4003 and FA-7002 Antenna Pedestals. The contractor shall submit the design data to the Contracting Officer for review and comment. The Government will review these data, and any subsequent revisions thereto, for compliance with this specification. Any applicable comments provided by the Government shall be included in a revision to these data by the contractor.

3.12.3 Tests. - All tests required by Section 4 of this specification shall apply to the prototype equipment. The equipment may be delivered after it has been reworked to new condition prior to acceptance.

3.12.4 Reliability and maintainability. - The contractor shall provide as a part of the design data, a detailed analysis on estimates of MTBF, MTTR, and preventive maintenance downtime for the equipment. Predictions on reliability and maintainability shall meet the requirements of 3.6. An estimate of the time required to install the equipment on each type of antenna pedestal shall also be included.

4. QUALITY ASSURANCE PROVISIONS

4.1 General. - The contractor shall be responsible for conducting all inspection and testing to assure product conformation with the requirements of this specification and shall utilize, for this purpose, a quality control program in accordance with FAA-STD-013. See also Section 1-4 of FAA-G-2100/1. In the event of a conflict between the provisions of paragraphs 1-4.1 and 1-4.2.2 through 1-4.2.5 of FAA-G-2100/1 and those of FAA-STD-013, the latter shall govern.

4.2 Performance tests. - Unless otherwise specified, all equipment shall be tested at the contractor's plant under dynamic conditions to simulate equipment operation when mounted on the antenna pedestal. The equipment shall be mounted in a test-jig standard and the APG input shaft coupled to a constant-speed drive mechanism. The test jig(s) shall be equivalent to the rotating mechanism in the antenna pedestal drive systems. The CA-4003 and FA-7002 Antenna Pedestals will not be furnished to the contractor for use during factory tests.

4.3 Design qualification tests

4.3.1 Service conditions. - The following design qualification tests shall be made while subjecting the equipment to the test procedure described under 1-4.3.3.2 of FAA-G-2100/1:

<u>Test</u>	<u>AC Line Voltage</u>	<u>Paragraph</u>
ACP count	120 V	3.4.; 3.4.6 (a)
Pulse amplitude	102 V, 138 V	3.4.6 (c)
Output isolation	138 V	3.4.6 (d)

4.3.2 Normal test conditions. - The following design qualification tests shall be made under normal test conditions:

<u>Test</u>	<u>Paragraph</u>
Input shaft acceleration rates up to 30 degrees per second per second	3.4.3 (a)
ARP adjustment range	3.4.3.1
Rating tests and general specification tests	1-4.3.2.1, 1-4.3.2.2, FAA-G-2100/1

4.4 Type tests

4.4.1 Service conditions. - The following type tests shall be made while subjecting the equipment to the test procedure described under 1-4.3.3.2 of FAA-G-2100/1:

<u>Test</u>	<u>AC Line Voltage</u>	<u>Paragraph</u>
Pulse amplitude	120 V	3.4.6 (c)
ACP and ARP count	120 V	3.5 (a); 3.5 (b)
ACP and ARP jitter	120 V	3.5 (c); 3.5 (d)

4.5 Production tests. - The following production tests shall be made under normal test conditions:

<u>Test</u>	<u>Paragraph</u>
ARP position	3.4.6 (b)
Pulse amplitude	3.4.6 (c)
ACP count	3.5 (a)

4.6 Field demonstration tests. - When specified in the contract schedule, the contractor shall perform field demonstration tests to verify that prototype equipment meets specification requirements when the equipment is mounted on the radar antenna pedestal. Tests shall be conducted by the contractor in accordance with a test plan prepared by the contractor and approved by the Contracting Officer. The test plan shall be sufficiently comprehensive to demonstrate equipment compliance with this specification and shall include, as a minimum, the following:

<u>Test</u>	<u>Paragraph</u>
ARP adjustment range	3.4.3.1
Mechanical isolation	3.4.3.2
Pulse amplitude	3.4.6 (c)
ACP and ARP jitter	3.5 (c); 3.5 (d)
Azimuth accuracy	3.5 (e)

The field demonstration shall include a two-week test period during which the equipment shall be operated continuously without interruption. All test equipment required to perform the tests shall be furnished by the contractor.

5. PREPARATION FOR DELIVERY

5.1 General packing requirements. - See MIL-E-17555.

6. NOTES

6.1 Note on information items. - The contents of this Section 6 are only for the information of the initiator of the procurement request and are not part of the requirements of the specification. They are not contract requirements nor binding on either the Government or the contractor. In order for these terms to become a part of the resulting contract, they must be specifically incorporated in the schedule of the contract. Any reliance placed by the contractor on the information in these subparagraphs is wholly at the contractor's own risk.

6.2 Intended use. - The equipment specified herein is intended for installation and use at Air Route Surveillance Radar sites to provide azimuth synchronization input that is required by Common Digitizer equipment for processing radar and beacon data.

6.3 Equipment options. - The contract schedule should state the quantity of Type I and Type II Azimuth Pulse Generator assemblies to be furnished. (See paragraph 3.4.3).

6.4 Optional prototype equipment. - When the contract requires prototype equipment (3.12) to be furnished, the contractor should be required to successfully complete the field demonstration tests (4.6) with the equipment installed at one or more operational ARSR facilities prior to proceeding with quantity production. Quantity production should be contingent upon approval of the prototype equipment. Other prototype equipment provisions are stated in the following subparagraphs.

6.4.1 Request for proposals. - When the procurement request requires the bidder to furnish prototype equipment, the following technical data should be submitted with the proposal:

- (a) Block diagrams. - Equipment block diagrams should be included in the proposal. The block diagrams should show the general operational, electrical, and physical relationships of the equipment elements.
- (b) Information flow diagrams. - The proposal should include complete equipment information flow diagrams. These diagrams should show the detailed operational and functional relationships of the equipment elements.
- (c) Input/Output details. - The proposals should include a summary of all equipment input/output characteristics. This should include: termination characteristics, signal characteristics and limits, and power requirements where necessary.
- (d) Detailed physical description. - The proposal should provide a detailed physical description of the equipment. This description should include; weights, measurements and outline drawings, configuration, layouts, cable entry and exit features, clearance factors, and other special details which should be considered for installation, operation, and maintenance of the equipment. Details of physical changes to the existing CA-4003 and FA-7002 Antenna Pedestals should be submitted.
- (e) Reliability and maintainability estimates. - The proposal should include a detailed analysis of the predicted reliability and maintainability (3.12.4) of the equipment being offered.

6.4.2 Design data. - The contract schedule should require the submission of prototype equipment design and reliability/maintainability data (3.12.2; 3.12.4) for review by the Contracting Officer prior to fabrication of prototype equipment. These data should be submitted within 90 days after contract award. Twenty days should be allowed for action by the Government.

6.4.3 Progress reports. - The contract schedule should require monthly progress reports for the prototype equipment beginning the first month after the effective date of the contract. Reports may be submitted in letter form.

6.4.4 Production parts. - The schedule should require the contractor to defer procurement of production parts prior to the approval of the prototype equipment or major components thereof. However, approval of components prior to the approval of the prototype unit should not relieve the contractor of the responsibility of complying with this specification.

6.4.5 Instruction booklets. - A modification of the requirements of FAA-D-1272 should be made applicable to contract which include a requirement for furnishing prototype equipment. A total quantity of 10 each Type I Instruction booklets, especially prepared to cover the prototype equipment should be delivered to the Contracting Officer. In addition, two Instruction Booklets should be shipped with each equipment furnished. All requirements of FAA-D-1272 should remain in effect regarding the furnishing of Type I and Type III Instruction Booklets for the production equipment to be provided by the contractor.

6.4.6 Prototype installation. - Field installation of the prototype equipment, when required, will be at the option of the Government. Request for proposals should require costs with and without contractor installation of the prototype equipment at one or more designated field facilities. In any case, complete installation instructions should be included in instruction booklets.

6.4.7 Test plan. - A test plan for use during field demonstration tests (4.6) should be prepared by the contractor and submitted for review and approval by the Contracting Officer prior to starting tests. The plan should be submitted within 30 days after approval of the design data (6.4.2).

6.5 Standard antenna pedestal samples. - Invitations for bid or request for proposals should state that standard samples of the antenna pedestals (3.11) will be available for inspection at the FAA Depot, Oklahoma City, Oklahoma. It should also be noted that the samples may not be completely assembled and will not include the radar antenna. However, all components that are normally housed within each type pedestal will be available for inspection. Applicable manufacturing drawings or their equivalent are unavailable for distribution.